GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

January 1992

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time allotted: 2½ hours

Total possible marks: 70

This is a **closed-book** examination consisting of **three** parts:

PART A has 42 multiple-choice questions each with a value of one mark.

PART B has seven numerical-response questions each with a value of one mark.

PART C has three written-response questions for a total of 21 marks.

A chemistry data booklet is provided for your reference.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

GENERAL INSTRUCTIONS

Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.

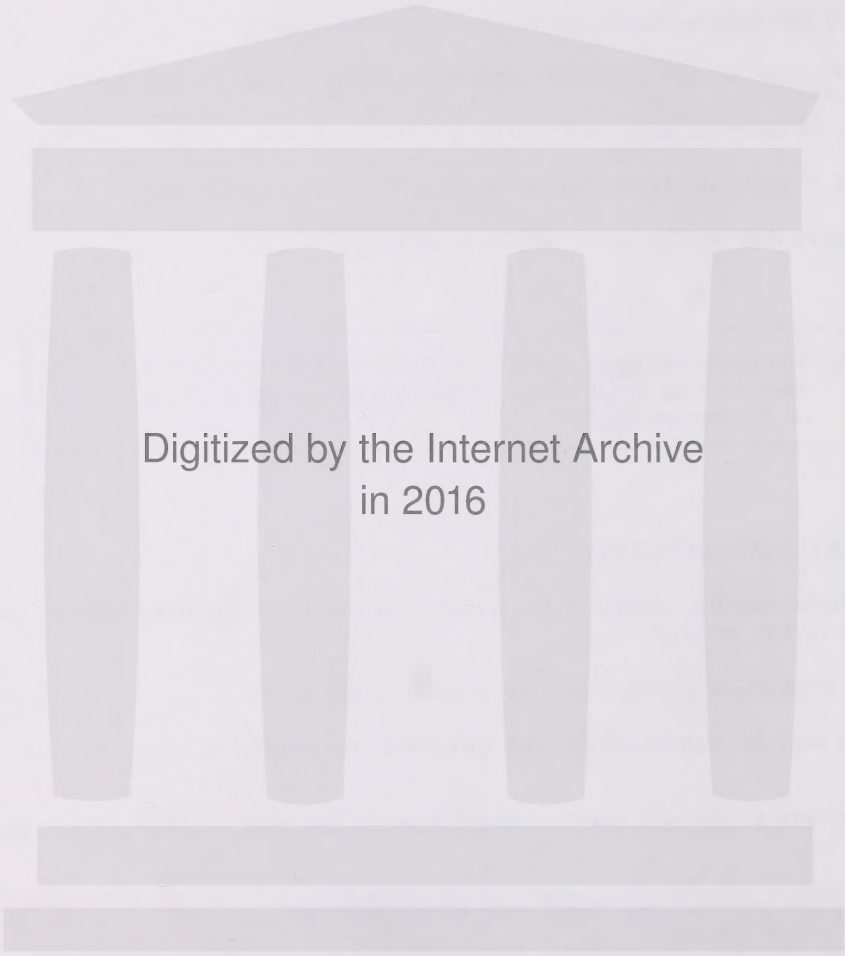
You are expected to provide your own scientific calculator.

Carefully read the instructions for each part before proceeding.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.

JANUARY 1992



PART A

INSTRUCTIONS

In this part of the examination, there are 42 multiple-choice questions each with a value of one mark. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully and decide which of the choices **best** completes the statement or answers the question. Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to Ⓐ your choice. **Use an HB pencil only**.

Example **Answer Sheet**

This diploma examination is for the subject of Ⓐ Ⓑ ● Ⓓ

A. biology
B. physics
C. chemistry
D. mathematics

If you wish to change an answer, erase your first mark completely.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

1. An increase in water temperature from 0°C to 50°C can primarily be explained as

A. kinetic energy increasing
B. kinetic energy decreasing
C. potential energy increasing
D. potential energy decreasing

2. The heat of formation for 40.31 g of $MgO_{(s)}$ is

A. +1203.4 kJ
B. +601.7 kJ
C. −601.7 kJ
D. −1203.4 kJ

Use the following data to answer question 3.

Molar Heat of Formation (kJ/mol)

$HI_{(g)}$	+26.5	$NaI_{(s)}$	−287.8
$HBr_{(g)}$	−36.4	$NaBr_{(s)}$	−361.1
$HCl_{(g)}$	−92.3	$NaCl_{(s)}$	−411.2

3. A generalization that could be made about these compounds is that

A. iodine forms stronger bonds than chlorine does
B. iodine compounds are less stable than chlorine compounds
C. hydrogen forms stronger bonds with halogens than sodium does
D. sodium halides are less stable than hydrogen halides

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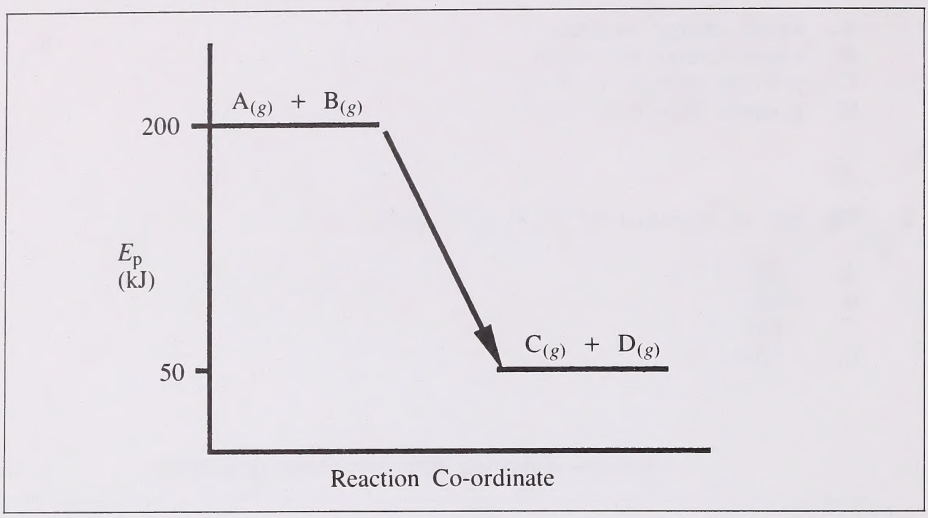
4. A reaction has a positive ΔH value. This means that

A. the reaction is exothermic
B. the reaction releases energy
C. during the reaction, the surroundings get colder
D. the heat content of the products is less than that of the reactants

Use the following information to answer question 5.



5. The equation that best explains this information is

A. $A_{(g)} + B_{(g)} \longrightarrow C_{(g)} + D_{(g)} + 150\ kJ$
B. $C_{(g)} + D_{(g)} \longrightarrow A_{(g)} + B_{(g)} + 150\ kJ$
C. $A_{(g)} + B_{(g)} \longrightarrow C_{(g)} + D_{(g)}$ $\Delta H = +150\ kJ$
D. $C_{(g)} + D_{(g)} \longrightarrow A_{(g)} + B_{(g)}$ $\Delta H = +150\ kJ$

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6. A nuclear reaction has a heat of reaction that is

A. less than that of a chemical change
B. at least 10^5 times greater than that of a chemical change
C. similar to the value for the molar heat of fusion of ice
D. generally equal to the sum of the heats of reaction for chemical and phase changes combined

Use the following equation to answer question 7.

$$SnO_{2(s)} + Zn_{(s)} \longrightarrow ZnO_{(s)} + SnO_{(s)}$$

7. The reaction is

A. exothermic and $Zn_{(s)}$ is the reducing agent
B. exothermic and $SnO_{2(s)}$ is oxidized
C. endothermic and $Zn_{(s)}$ is reduced
D. endothermic and $SnO_{2(s)}$ is the oxidizing agent

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8. The heat of reaction for $SnO_{2(s)} + 4HCl_{(g)} \longrightarrow SnCl_{4(l)} + 2H_2O_{(g)}$ is

A. +196.8 kJ
B. +45.0 kJ
C. −45.0 kJ
D. −1830.4 kJ

Use the following information to answer question 9.

Volume of water	300 mL
Temperature change	4.00°C
Amount of heat added	4.78 kJ

9. When these data are used to determine the specific heat capacity of water, the per cent error of this value is

A. 4.53%
B. 4.93%
C. 14.1%
D. 95.1%

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10. 25.0 g of ice at the melting point are added to calorimeter water at 25.4°C. When thermal equilibrium is reached, the final temperature of the mixture is 15.0°C. The original volume of water in the calorimeter was

A. 93.4 mL
B. 136 mL
C. 209 mL
D. 228 mL

11. Which statement is correct?

A. $\Sigma H^\circ_{f(PRODUCTS)} = \Sigma H^\circ_{f(REACTANTS)}$

B. $\Delta H = \Sigma H^\circ_{f(PRODUCTS)} - \Sigma H^\circ_{f(REACTANTS)}$

C. $\Delta H = \Sigma H^\circ_{f(REACTANTS)} = \Sigma H^\circ_{f(PRODUCTS)}$

D. $\Sigma H^\circ_{f(PRODUCTS)} = \Delta H - \Sigma H^\circ_{f(REACTANTS)}$

Use the following information to answer question 12.

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(g)}$	$\Delta H = -242$ kJ
$H_{2(g)} \longrightarrow 2H_{(g)}$	$\Delta H = +437$ kJ
$\frac{1}{2}O_{2(g)} \longrightarrow O_{(g)}$	$\Delta H = +248$ kJ

12. The change in enthalpy for the atomization of $H_2O_{(g)}$, $H_2O_{(g)} \longrightarrow 2H_{(g)} + O_{(g)}$, is

A. -927 kJ
B. -443 kJ
C. $+443$ kJ
D. $+927$ kJ

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13. If you are ''burning the candle at both ends'' rather than one, when the candle is completely burned the

A. ΔH for the combustion of candle wax will double
B. total heat produced by the entire candle will double
C. heat released per mole of wax burned will remain unchanged
D. ΔH_f° for the formation of candle wax will double

14. Ethanal, $CH_3CHO_{(g)}$, burns in oxygen to produce carbon dioxide, water, and heat. Which statement describes this reaction?

A. The reducing agent is oxygen.
B. The substance reduced is ethanal.
C. The reactants are more acidic than the products.
D. The total potential energy of the products is less than the total potential energy of the reactants.

15. The property that acids and bases have in common is that they

A. conduct electricity
B. turn red litmus blue
C. turn blue litmus red
D. taste sour

16. When butter goes rancid, it has a sour taste. One should also expect it to

A. react with $Zn_{(s)}$ to form $H_{2(g)}$
B. neutralize $HCl_{(aq)}$
C. turn litmus blue
D. have a pH $>$ 7

17. Which solution can neutralize or partially neutralize both acidic and basic solutions?

A. $HCOO^-_{(aq)}$

B. $CH_3COO^-_{(aq)}$

C. $HCO_3^-{}_{(aq)}$

D. $S^{2-}_{(aq)}$

18. A base added to a neutral aqueous solution will

A. decrease $[OH^-_{(aq)}]$

B. decrease $[H_3O^+_{(aq)}]$

C. decrease the pH of the solution

D. donate protons to another substance in the solution

19. Choose the equation in which $HSO_3^-{}_{(aq)}$ exhibits the behavior of a Brønsted-Lowry base.

A. $HSO_3^-{}_{(aq)} + HClO_{4(aq)} \leftrightharpoons HSO_4^-{}_{(aq)} + HClO_{3(aq)}$

B. $HSO_3^-{}_{(aq)} + H_2PO_4^-{}_{(aq)} \leftrightharpoons H_2SO_{3(aq)} + HPO_4^{2-}{}_{(aq)}$

C. $HSO_3^-{}_{(aq)} + H_2O_{(l)} \leftrightharpoons H_3O^+_{(aq)} + SO_3^{2-}{}_{(aq)}$

D. $HSO_3^-{}_{(aq)} + HCO_3^-{}_{(aq)} \leftrightharpoons SO_3^{2-}{}_{(aq)} + H_2CO_{3(aq)}$

20. Which anion is the weakest base?

A. $F^-_{(aq)}$

B. $Ph^-_{(aq)}$

C. $SO_4^{2-}{}_{(aq)}$

D. $HSO_4^-{}_{(aq)}$

21. An apple was analysed and found to have a pH of 3.30. The $[OH^-_{(aq)}]$ for this sample is

A. 1.0×10^{-3} mol/L

B. 5.0×10^{-4} mol/L

C. 2.0×10^{-11} mol/L

D. 1.0×10^{-10} mol/L

22. Which of these 0.10 mol/L solutions has a pH of 7.00?

A. $Na_2CO_{3(aq)}$
B. $KCl_{(aq)}$
C. $KCN_{(aq)}$
D. $HF_{(aq)}$

Use the following information to answer question 23.

A solution is tested with a number of indicators in order to determine its pH. The results of the tests are summarized in the table.

Indicator	Color
methyl violet	blue
phenol red	red
indigo carmine	blue
phenolphthalein	colorless

23. The pH of the solution is approximately

A. 5.2
B. 6.0
C. 8.1
D. 11.4

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24. Solutions of hydrochloric acid and sodium hypochlorite are combined. The net ionic equation for the reaction that occurs is

A. $HCl_{(aq)} + NaOCl_{(aq)} \longrightarrow NaCl_{(aq)} + HOCl_{(aq)}$

B. $H^+_{(aq)} + NaOCl_{(aq)} \longrightarrow Na^+_{(aq)} + HOCl_{(aq)}$

C. $HCl_{(aq)} + OCl^-_{(aq)} \longrightarrow HOCl_{(aq)} + Cl^-_{(aq)}$

D. $H_3O^+_{(aq)} + OCl^-_{(aq)} \longrightarrow H_2O_{(l)} + HOCl_{(aq)}$

25. HX is a weak acid. In a 0.10 mol/L $HX_{(aq)}$ solution, the species present in highest concentration is

A. $HX_{(aq)}$
B. $X^-_{(aq)}$
C. $H_3O^+_{(aq)}$
D. $OH^-_{(aq)}$

26. If 0.10 mol/L solutions of $HOCl_{(aq)}$ and $KCH_3COO_{(aq)}$ are mixed together, the following equilibrium is established:

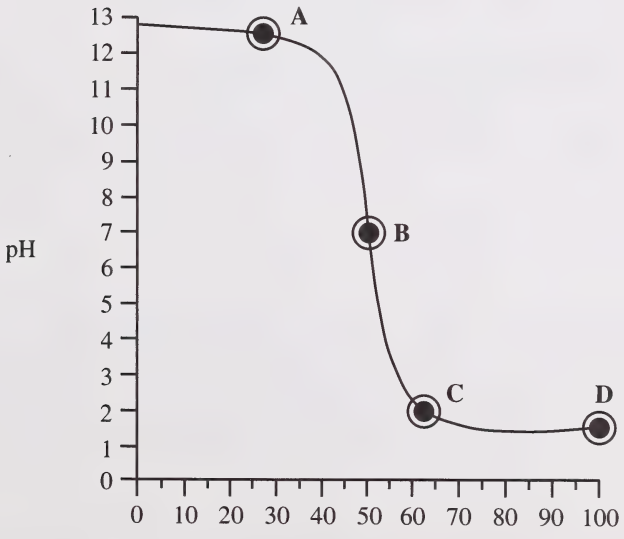
$$HOCl_{(aq)} + CH_3COO^-_{(aq)} \leftrightharpoons OCl^-_{(aq)} + CH_3COOH_{(aq)}$$

This equilibrium

A. favors the reactants
B. favors the products
C. favors neither side because all concentrations are equal
D. is impossible to predict, given the information available

27. At which point on the graph does the $[OH^-_{(aq)}]$ equal the $[H_3O^+_{(aq)}]$?

Titration Curve for $NaOH_{(aq)}$ with $HCl_{(aq)}$



28. 1.80 g of $CH_3COOH_{(l)}$ are dissolved in enough water to make 300 mL of solution. If the indicator dropped into the solution is

A. orange IV, the color of the solution will be orange
B. bromothymol blue, the color of the solution will be blue
C. methyl violet, the color of the solution will be yellow
D. thymol blue, the color of the solution will be yellow

29. In redox reactions,

A. oxidizing agents lose electrons and are oxidized
B. reducing agents lose electrons and are reduced
C. oxidizing agents gain electrons and are reduced
D. reducing agents gain electrons and are oxidized

30. An oxidation-reduction reaction is

A. $H_3O^+_{(aq)} + HS^-_{(aq)} \longrightarrow H_2S_{(aq)} + H_2O_{(l)}$

B. $F^-_{(aq)} + HF_{(aq)} \longrightarrow HF_2^-{}_{(aq)}$

C. $2Br^-_{(aq)} + Cl_{2(g)} \longrightarrow Br_{2(aq)} + 2Cl^-_{(aq)}$

D. $2OH^-_{(aq)} + SO_{2(g)} \longrightarrow SO_3^{2-}{}_{(aq)} + H_2O_{(l)}$

31. Which process could cause $X^{2-}_{(aq)}$ to change to $X^+_{(aq)}$?

A. $Z_{(s)} \longrightarrow Z^{3-}_{(aq)}$
B. $Z_{(s)} \longrightarrow Z^{3+}_{(aq)}$
C. $Z^{2-}_{(aq)} \longrightarrow Z^+_{(aq)}$
D. $Z^{3-}_{(aq)} \longrightarrow Z_{(s)}$

32. Which substance contains an ''atom'' with an oxidation number of 0?

A. F_2
B. NaH
C. H_2O_2
D. N_2O_2

33. When $Fe_{(s)}$ is placed in a solution containing $Cu(NO_3)_{2(aq)}$ and $MgCl_{2(aq)}$, the balanced equation for the most likely redox reaction is

A. $3Cu^{2+}_{(aq)} + 2Fe_{(s)} \longrightarrow 2Fe^{3+}_{(aq)} + 3Cu_{(s)}$

B. $Cu^{2+}_{(aq)} + Fe_{(s)} \longrightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$

C. $Cu_{(s)} + 2Fe^{3+}_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + 3Cu^{2+}_{(aq)}$

D. $Mg^{2+}_{(aq)} + 2Cl^{-}_{(aq)} \longrightarrow Mg_{(s)} + Cl_{2(g)}$

34. A strong oxidizing agent is to be titrated using a strong reducing agent. The **least** accurate titration technique would be to add the oxidizing agent to the reducing agent by using a

A. graduated cylinder
B. medicine dropper
C. beaker
D. buret

Use the following information to answer question 35.

In an experiment, 0.215 mol/L $KMnO_{4(aq)}$ was used to determine the concentration of an acidified $Sn^{2+}_{(aq)}$ solution, and these data were obtained:

	Trial			
	I	II	III	IV
Volume of $Sn^{2+}_{(aq)}$ (mL)	10.00	10.00	10.00	10.00
Buret final volume (mL)	11.26	22.15	33.03	43.93
Buret initial volume (mL)	0.0	11.26	22.15	33.03
Volume of $KMnO_{4(aq)}$ used (mL)	11.26	10.89	10.88	10.90

35. The most likely reason that trial I required more $KMnO_{4(aq)}$ than the other trials is that the

A. flask into which the $Sn^{2+}_{(aq)}$ was pipetted may have been wet
B. pipet used to transfer the $Sn^{2+}_{(aq)}$ sample was wet
C. clean and dry buret was not rinsed before it was filled
D. tip of the buret was not filled with $KMnO_{4(aq)}$

Use the following information to answer question 36.

In a titration experiment, a 0.0800 mol/L solution of acidic $K_2Cr_2O_{7(aq)}$ was used to oxidize $Sn^{2+}_{(aq)}$ to $Sn^{4+}_{(aq)}$, and these data were obtained:

Volume of $Sn^{2+}_{(aq)}$ solution	20.0 mL
Final buret reading of acidified $K_2Cr_2O_{7(aq)}$	73.4 mL
Initial buret reading	14.4 mL

36. What was the concentration of $Sn^{2+}_{(aq)}$?

A. 0.708 mol/L
B. 0.236 mol/L
C. 8.14×10^{-2} mol/L
D. 2.84×10^{-4} mol/L

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37. The electrode potential for the reduction of a hydrogen half-cell is 0.00 V. What is the electrode potential for the oxidation?

A. −1.23 V
B. 0.00 V
C. +0.83 V
D. +1.23 V

38. A student gathers information to determine the reactivity of fluorine gas. If the information is accurate, then a correct statement would be that

A. $Li_{(s)}$ gains electrons more easily than does $F_{2(g)}$
B. $F_{2(g)}$ loses electrons more easily than does $Li_{(s)}$
C. $F_{2(g)}$ loses electrons more easily than does $Cl_{2(g)}$
D. $F_{2(g)}$ gains electrons more easily than does $Cl_{2(g)}$

39. The reaction $A^{2+}_{(aq)} + X_{(s)} \longrightarrow A_{(s)} + X^{2+}_{(aq)}$ proceeds spontaneously. Elements $A_{(s)}$ and $X_{(s)}$ respectively could be

A. $Cr_{(s)}$ and $Co_{(s)}$
B. $Pb_{(s)}$ and $Cu_{(s)}$
C. $Co_{(s)}$ and $Cu_{(s)}$
D. $Ni_{(s)}$ and $Zn_{(s)}$

40. A $Sn_{(s)}/Sn^{2+}{}_{(aq)}$ half-cell and a $Zn_{(s)}/Zn^{2+}{}_{(aq)}$ half-cell, each containing 1.0 mol/L solutions, are connected to form an electrochemical cell. The net voltage of this cell is

A. -0.90 V
B. -0.62 V
C. $+0.62$ V
D. $+0.90$ V

41. The substance that would oxidize $Fe_{(s)}$ to $Fe^{2+}{}_{(aq)}$ in a neutral solution is

A. $AgNO_{3(aq)}$
B. $NaNO_{3(aq)}$
C. $LiNO_{3(aq)}$
D. $KNO_{3(aq)}$

42. In an electrochemical cell,

A. the strongest oxidizing agent reacts at the anode
B. gain of electrons occurs at the cathode
C. anions migrate toward the cathode
D. reduction occurs at the anode

YOU HAVE NOW COMPLETED PART A. PROCEED DIRECTLY TO PART B.

PART B

INSTRUCTIONS

In this part of the examination, there are seven numerical-response questions each with a value of one mark. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully.

Record your answer on the answer sheet provided by writing it in the boxes and filling in the corresponding circles.

Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.

Use an HB pencil only.

Sample Calculation Question and Solution

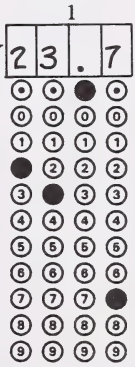
The mass in grams of silver produced when 0.220 mol of silver nitrate reacts with excess copper is _____ g. (Record your answer to three digits.)

$$\begin{aligned} \text{mass}_{Ag} &= 0.220 \text{ mol} \times 107.87 \text{ g/mol} \\ &= 23.7314 \text{ g} \\ &= 23.7 \text{ g (rounded to three digits)} \end{aligned}$$

Record 23.7

Answer Sheet

1



Sample Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____ . (Record all four digits.)

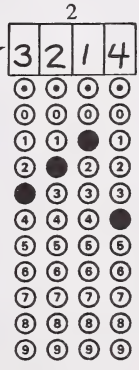
1. mathematics
2. chemistry
3. biology
4. physics

Answer 3, 2, 1, 4

Record 3214

Answer Sheet

2



If you wish to change an answer, erase **all** traces of your first answer.

START PART B IMMEDIATELY.

Use the following information to answer question 1.

1. $H_2O_{(g)} \longrightarrow H_2O_{(l)}$
2. $H_2O_{(l)} \longrightarrow H_2O_{(s)}$
3. ${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n$
4. $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(g)}$

1. When these changes are arranged in order of increasing magnitude of energy involved, the order is _____ . (Record all four digits.)

Use the following information to answer question 2.

$$S_{8(s)} + 8O_{2(g)} \longrightarrow 8SO_{2(g)} \qquad \Delta H = -2374.4 \text{ kJ}$$

2. If 3.20 g of $SO_{2(g)}$ are produced, the amount of heat released will be _____ kJ. (Record your answer to three digits.)

Use the following data and key to answer question 3.
Assume that all species are aqueous.

Data	
$HA + B^- \longrightarrow HB + A^-$	reactants favored
$HC + D^- \longrightarrow HD + C^-$	products favored
$HD + B^- \longrightarrow HB + D^-$	products favored

Key			
1.	HA	5.	A^-
2.	HB	6.	B^-
3.	HC	7.	C^-
4.	HD	8.	D^-

3. When these acids are arranged in order of decreasing strength, the order is _____ . (Record all four digits.)

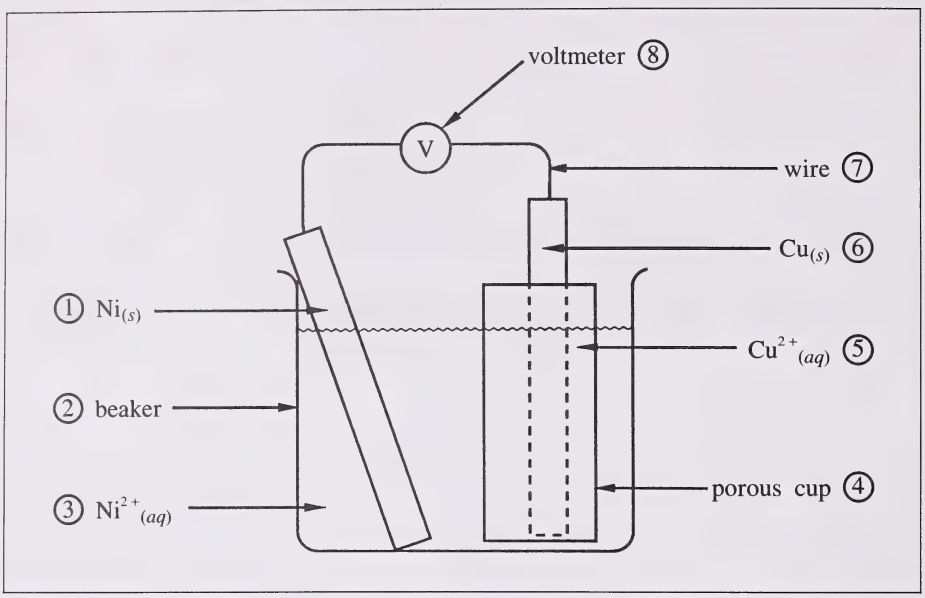
4. Nicotinic acid, $HC_2H_4NO_{2(g)}$, is a B vitamin. A student tested a 0.0100 mol/L sample and found its pH to be 3.430. The per cent dissociation of the acid is _____ %. (Record your answer to three digits.)

Use the following reaction to answer question 5.

$$2NO_3^-{}_{(aq)} + 4H^+{}_{(aq)} + Zn_{(s)} \longrightarrow 2NO_{2(g)} + 2H_2O_{(l)} + Zn^{2+}{}_{(aq)}$$

5. The $E°_{net}$ for the reaction is _____ V. (Record your answer to three digits.)

Use the following diagram to answer question 6.



6. When the electrochemical cell is operating, the

- anode is _____ (record in first column)
- cathode is _____ (record in second column)
- reducing agent is _____ (record in third column)
- oxidizing agent is _____ (record in fourth column)

RECORD THE ANSWER ON THE ANSWER SHEET

7. The mass of $Zn_{(s)}$ electroplated from a solution of $Zn^{2+}{}_{(aq)}$ by an electron flow of 10.0 A running for 6.00 h is _____ g. (Record your answer to three digits.)

RECORD THE ANSWER ON THE ANSWER SHEET

YOU HAVE NOW COMPLETED PART B. PROCEED DIRECTLY TO PART C.

PART C

INSTRUCTIONS

In this part of the examination, there are three written-response questions for a total of 21 marks. All numbers used in the questions are to be considered as the result of a measurement.

Read each question carefully.

Write your answer in the examination booklet as neatly as possible.

For full marks, your answer **must show** all pertinent explanations, calculations, and formulas. Your answer **should be** presented in a well organized and appropriate manner; for example, complete sentences for a written response, and correct units and significant digits for a numerical response.

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START PART C IMMEDIATELY.

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(7 marks)

1. You are assigned the task of determining the specific heat capacity of an unidentified metal. You are given a sample of the metal and have available the apparatus and materials common to high school chemistry laboratories.

   a. Write an experimental procedure and identify measurements that would enable you to successfully determine the specific heat capacity of the metal.

   b. Explain the scientific principle you used to determine the specific heat capacity.

2. Examine the results of tests performed on the following 0.10 mol/L solutions:

Solution	Reacts with zinc	Conducts electricity	Color in thymol blue
I	no	no	yellow
II	yes	yes	orange
III	yes	yes	red
IV	no	yes	blue

Classify each solution as acidic, basic, neutral ionic, or neutral molecular. Indicate which test results are essential to classifying the solution and explain why.

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(6 marks)

3. Jane lowered a copper strip into a glass beaker containing 200.0 mL of 0.100 mol/L $AgNO_{3(aq)}$. The beaker was then sealed and left to sit overnight. Next day, she observed that some of the copper strip remained.

   a. Assuming that the reaction went to completion, use half-reactions to write the net ionic redox reaction that occurred and then calculate the copper(II) ion concentration of the solution.

   b. Give one other observation that Jane could have made.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

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M1 M2 M3 M4

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